Estimation of the Relationship Between Lakeside Property Values and a Stripmine Environmental Impact

ESO 2276

by

Lauren Friedman and Fred J. Hitzhusen*

*Graduate Associate and Professor, respectively, The Department of Agricultural Economics, The Ohio State University, Columbus, Ohio 43210 November 1995

Abstract

This paper applies a hedonic price model to estimate the price effects of a stripmine-impacted lake on value of cottage properties adjacent to the lake. A data set of 103 homes was used. The results show that proximity to the impact is negatively related to house value.

Estimation of the Relationship Between
Lakeside Property Values and a Stripmine Environmental Impact

Objective

The purpose of this study is to estimate the relationship between lakes impacted by stripmine runoff and property values of homes adjacent to the lakes. This will be done by using a hedonic price function. The null hypothesis that will be tested is that the impact caused by the stripmining has no effect on property value. This is an interesting and important research problem, because if it can be shown that abandoned stripmines impact lakes and this impact negatively affects property value for homeowners, a justification for reclamation may become more apparent. These results have important policy implications with respect to reclamation and disposal of power plant wastes.

Background of the Problem

Coal stripmining in the United States, particularly in the Ohio River Valley and the Appalachian Regions, has contributed to many environmental problems. Currently in Ohio, high sulfur coal is being mined extensively in the eastern part of the state. Combustion of this high sulfur coal for electric generation results in SO_2 emissions and an acid rain problem. Scrubbers to remove the SO_2 creates a by-product, fluidized gas desulfurization (FGD) waste which may have potential for neutralizing acid spoils at mine sites. However, it may also have detrimental impacts if not handled properly (Hitzhusen and Hite et al.).

This paper addresses a specific problem associated with unreclaimed stripmines, which is the impact on nearby lakes. This impact usually involves a severe discoloration of the water, due to acid mine drainage, and an odor problem that is due to excess sulfur in the water. This causes an unpleasant hydrogen sulfide smell.

In this study, values of cottages on two lakes are examined. The lakes are Piedmont Lake and Leesville Lake. The cottages on both lakes are primarily used for summer vacation homes rather than permanent residences. Piedmont Lake has been impacted by abandoned stripmines. U.S. Geological Survey mapping in 1976 showed that one-third of this drainage basin had been strip-mined, two-thirds of which had been reclaimed, at least to earlier standards. The main impacts are concentrated at one end of the lake. This impact was present before the dams were built and the cottages constructed. Leesville Lake has not been impacted by strip-mining. U.S.G.S. mapping in 1978 showed that less than 0.5% of this drainage basin has had strip-mining activity.

The two lakes are close in geographical area and have homogeneous features. Both are used for boating, camping, and vacation home sites. Both have the same restrictions on horsepower for boating (10 hp max). Individuals have privately built and owned homes on lots leased from the Muskingum Water Conservency District (MWCD). They are 14 year leases with automatic renewal. Certain specifications on the homes are required under the leases. For example, guidelines regarding color, landscape, and roof style are specified in the lease. Plans must be submitted to MWCD for any new cottages or any major renovations.

Related Research

Griliches (1961) was the first to use a hedonic pricing model to value quality changes in automobiles. An early example of the use of property values to estimate willingness to pay for environmental quality improvements is the Ridker and Henning (1967) study. Their work was aimed at the measurement of the value of clean air for neighborhoods in St. Louis. They used a regression of a hedonic equation to estimate marginal implicit prices and from these prices determined willingness to pay for air quality improvements.

Freeman (1971) contends that willingness to pay can be estimated from marginal implicit prices for marginal changes, however this is inappropriate for non-marginal changes. Rosen (1974) developed a two stage procedure to estimate demand for a characteristic. Described in a general way, the first stage is the estimation of marginal implicit prices, and the second stage incorporates other variables to estimate demand. This analysis will focus on the first stage of this hedonic price analysis procedure.

Methodology

Hedonic pricing is a method of determining willingness to pay for environmental goods. A basic concept of the hedonic method is that the value of an asset (in this case a home) is a function of the set of its characteristics. This can be expressed as:

(1) $\mathbf{P = f(S,C,Q)}$,

where P = price of value of the house, S = structural characteristics, C = community characteristics, and Q = environmental quality characteristics. This is called the hedonic price function. Each of these variables represent the various contributors toward the value of the house.

The hedonic pricing function consists of property value as the dependent variable and all of the individual characteristics as independent variables. Using this function, the change in property value with a change in an environmental characteristic holding all other characteristics constant can be measured by taking the derivative with respect to the environmental quality characteristic. This gives the marginal implicit price of the individual characteristics.

Functional Form

When developing a hedonic model there are several things that must first be considered. One of these is the functional form that is to be used. Various forms may be tried including, linear, log-linear, log-log, quadratic, etc.

Anderson and Bishop (1986) state that although economic theory offers very little information dealing with choosing functional form, theory does tell us that the linear form can probably be rejected. This form assumes that the implicit price is constant regardless of the amount of the attribute. This assumption can be rejected because we know that the current level of an environmental quality attribute will influence the willingness to pay for more of the attribute. If an individual already has a great deal of an attribute, he/she is probably not willing to pay much for more, while if an individual has very little of an attribute, he/she will likely be willing to pay more for an additional unit. Therefore, it follows that the linear specification can be eliminated from the choices.

It seems most reasonable to choose the form that features the appropriate attributes of the variables such as diminishing marginal utility. In this case, the double-log form will be used. This is the logical form because of decreasing marginal utility of the variables.

Specifying the Dependent Variable

There is some discussion in the literature regarding the most appropriate way to specify property value. The most readily available data is the tax assessed value. The tax assessed value of property is available from any county auditors' office. This is usually measured by examining the structural characteristics of the house, as well as observing recent sales of similar, close-by houses. Both are used to predict what the market value of the home would be. It is commonly agreed that the use of assessed values causes a potential problem. Assessors in different counties may use different methods to value a home. Also there may be amenities or disamenities that are difficult for assessors to value, such as views, and these may be left out.

The logical solution would be to use sale values for the dependent variable. The problem is in data availability. In a small sample, it is sometimes difficult to find a large enough sample size, because each home will not sell each year. Some researchers have solved this problem by developing predictive models to estimate sale values based on assessed value, and other locational specific characteristics.

A predictive model was developed for this study. A detailed description of this model will not be presented in this paper due to length considerations. However, it was found that using assessed values vs. predicted sale values based on a subset of actual sale values did not significantly effect the results.

Model Specification

The hedonic price function for the model developed for this study can be expressed as:

$$\text{(2)} \quad \mathbf{lnprice = a + B_1 lnlot + B_2 lnsqft + B_3 age + B_4 elev + B_5 baths + B_6 firepl + B_7 base + B_8 porch + B_9 rooms + B_{10} \#homes + B_{11} lakev + B_{12} lndistlk + B_{13} lnunim + B_{14} 1/lnd + e}$$

where,

lnprice = predicted sale value of the cottages

a = intercept term

lnlot = size of lot in square feet

lnsqft = square footage of the cottage

age = age of the cottage in years

elev = elevation in feet above lake

baths = number of bathrooms

firepl = 1 if fireplace, otherwise 0

base = 1 if basement, otherwise 0

porch = 1 if porch, otherwise 0

rooms = number of rooms

#homes = number of homes in the development

lakev = 1 if view is of lake, otherwise 0

lndistlk = distance to the lake in feet

lnunim = distance to the highway that is unimproved

lnd = distance to the impacted part of the lake in feet

e = stochastic disturbance term

Some of the variables may require further explanation regarding their meaning. "#homes" refers to number of homes in the development. Each lake has four developments, each having varying numbers of cottages. The variable named "lakev", refers to whether the cottage faces the lake or an inlet. A few of the developments have cottages which only face an inlet. "invlnd" is the environmental quality variable and will be clarified in the next section.

Due to the nature of the market for summer homes versus permanent residences, some of the community characteristics which are generally found in hedonic analyses are not relevant here. Some of these, for example, crime, are assumed to be consistent between the two lakes. Demographic variables such as quality of schools, race, and education while relevant in a normal housing market, are assumed to be unimportant factors regarding decisions to buy a summer home.

The Environmental Quality Variable

Distance to the impacted part of the lake is the environmental quality variable in this model. This distance variable is used instead of using paired comparisons between the impacted and unimpacted lakes. This is because the underlying hypothesis is that there is a difference in house values that is due to the impact and this is not only a difference between the two lakes but also within the impacted lake, according to the amount of distance between the cottages and the impact.

In order to account for both differences in homes between the two lakes and differences in homes within the impacted lake, a dummy variable was set up according to d=0 for the unimpacted lake and d=1 for the impacted lake. Then the product d*1/distance was calculated with distance equaling the distance to the impacted part of the lake. Inverse distance is used here because a value of zero represents zero impact. As the effect of the impact (distance) increases, the value increases. The result of this multiplication is used in the equation as the environmental quality variable. The values for all of the Leesville Lake observations will be zero. The Piedmont Lake observations will be the inverse of the distance to the impact. This value will consequently be negatively related to price. As the distance to the impact gets smaller, the inverse distance increases and the price decreases.

Data Collection

Data on prices and structural characteristics was collected from the county auditors offices and from the MWCD offices. Data on distances was gathered from maps.

Results

The model was estimated using the predicted sale values as the dependent variable. The results are presented in Table 1.

All of the coefficients had the expected signs except for distance to the lake. It was hypothesized that this would be negatively related to price. The reasoning was that people would prefer to be closer to the lake. However, it could be that closer properties have more flooding problems. Alternatively, homes further from the lake may have better views due to higher elevation. Elevation was included in the model and was expected to be important because there is variability in elevation among the lots. However elevation was not statistically significant.

These unexpected results may be due to the limitations of the data available. Distance to the lake and elevation alone do not explain all of the differences in the quality of the lots. Some of the homes are at high elevations and have clear views of the lake, and others are lower with clear views. Others have less of a view due to tree density, but these also occur at various elevations and distances from the lake. To correct for these differences, a careful, individual assessment of the lots would have to be done.

Table 1. Regression results

variable	coefficient	t-statistic	probability of committing a Type I error
acres	0.0178	0.2417	0.405
square feet	0.2172	4.0046	0.000065
elevation	2.24×10^{-6}	0.2731	0.393
age	-8.7×10^{-6}	-0.2990	0.383
distance to lake	0.0388	1.3215	0.095
# of homes	0.0024	1.0435	0.15
lake view	0.0813	1.5226	0.066
# of rooms	0.0529	3.3633	0.001
# of baths	0.1102	1.6475	0.052
fireplace	0.0406	0.9930	0.162
basement	0.0618	1.7679	0.04
porch	0.0810	1.8928	0.031
distance unimproved	-0.0063	-0.2097	0.417
inv. dist. to impact	-0.1956	-1.8599	0.033

The variable of greatest importance in this study is the distance to the impact. As was hypothesized, the inverse distance is negatively related to price. This can be interpreted as a positive relationship between distance and property value.

To derive the marginal implicit price for the environmental quality variable, the first derivative of $\ln P = a_{14}(1/(\ln d)^2)$ is computed.

$$(3) \qquad \frac{d\ln P}{d\ln d} = -a_{14}(\ln d)^{-2} = -a_{14}(1/(\ln d)^2)$$

dlnP/dlnd is by definition the elasticity, therefore

$$(4) \qquad \frac{d\ln P}{d\ln d} = \frac{dP}{dd}\,\frac{d}{P}\,.$$

Rearrange to find marginal implicit price(MIP) for distance to the impact:

$$(5) \qquad dP/dZ = -P/Z{*}a(1/(\ln Z)^2).$$

Marginal implicit prices were calculated for each observation on the impacted lake. The average MIP is 10.14. The average distance to the impact is 25,800 feet. Keeping in mind that distance to the impact is measured in 1,000 ft. units, the average MIP, 10.14 can be interpreted as a $10.14 increase in property value per year for a one unit increase in distance from the impact for cottages which are 25,800 feet away (one unit of distance = 1,000 ft).

The marginal implicit price will be different for each observation. Each house has a different price and is a different distance from the impact. The diminishing marginal returns concept is that the incremental increases in distance from impact for homes close to the impact have a larger effect on price, than increases for homes further away. Using an average yearly house price of $3519.00, marginal implicit prices were calculated for the average house at various distances from the impact.

These implicit prices can be interpreted as the change in property value with a one unit (1,000 ft) change in distance to the impact. As Table 2 illustrates, the MIP is different for cottages which are at different distances. These MIP's represent the average house in terms of value. For homes of different value, the MIP will be different.

Table 2. Marginal Implicit Prices

distance to the impact	marginal implicit price
5 units (5,000 feet)	$53.49
10 units (10,000 feet)	$13.02
30 units (30,000 feet)	$1.98
50 units (50,000 feet)	$0.91

Summary

The results show that the stripmining impact on Piedmont Lake has a negative effect on property values of homes on the lake. The marginal implicit prices were calculated and while different for each observation, the average MIP was 10.14. For a 1,000 ft. increase in distance to the impact, price increases by $10.14.

To determine the demand for distance to the impact, a second stage, using the marginal implicit prices must be done. However, these results show that there is a significant difference in property value that is due to the environmental impact. This is an important finding from a policy prospective, particularly regarding the economic potential for using power plant FGD by-product to reclaim stripmines. Further research is warranted and should involve a second stage estimation of the hedonic price function. Additionally, a collection of primary data with respect to the lot quality and view would be beneficial if time and budget are sufficient.

References

Anderson, G. and Bishop, R. "The Valuation Problem" in *Natural Resource Economics*. ed. David Bromley, Kluwer Nijhoff Publishing. Boston, 1986.

Freeman, A. Myrick, III. "Air Pollution and Property Values: A Methodological Comment." *Review of Economics and Statistics* 53:(1971)415-16.

Hite, Diane, Wen Chern and Fred Hitzhusen. "Analysis of the Welfare Impacts of Landfilling Coal FGD By-Products," published in the *Proceedings of the 1994 Pittsburgh Coal Conference*, Pittsburgh, September 1994.

Hitzhusen, Fred J. "Social Costs and Benefits of Recycling Coal-Fired Electric Power Plants FGD By-Products," ESO 1996, Department of Agricultural Economics and Rural Sociology, The Ohio State University, 1992.

Griliches, Z., ed. *Price Indices and Quality Change: Studies in New Methods of Measurement.* Cambridge, Mass.: Harvard University Press, 1971.

Ridker, Ronald G. and Henning, John A. "The Determinants of Residential Property Values with Special Reference to Air Pollution." *Review of Economics and Statistics* 49:(1967) 246-56.

Rosen, Sherwin. "Hedonic prices and implicit markets: Product differentiation in pure competition". *Journal of Political Economy* 82:(1974)34-55.